Remote Sediment Property From Chirp Data Collected During ASIAEX

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LONG TERM GOALS

The long term research objective is to develop a cost effective technique for mapping the top 20 meters of sediment properties using acoustic remote sensing. In previous years, a chirp sonar was developed to provide quantitative, wideband reflection measurements of the seabed with a vertical resolution of 10 cm. Neural network and fuzzy logic techniques have been used to automatically detect subsurface layer interfaces and to find the boundaries between sediment layers. Signal processing techniques were developed to estimate vertical profiles of impedance, attenuation and volume scattering coefficients. The procedures for remotely estimating sediment properties are being verified using core data and insitu measurements. New signal processing techniques have been developed that allow several sources transmitting simultaneously in different bands to build a wideband FM pulse in the far field. That wideband data is being used to improve the accuracy of the sediment classification procedures.

OBJECTIVES

1) Conduct chirp sonar surveys to provide imagery of sediment layering and acoustic sediment properties needed by ASIAEX investigators modeling acoustic propagation in the South and East China Seas.

2) Compare remote chirp measurements of sediment properties with direct property measurements made from cores to determine the accuracy of remote predictions.

3) Deliver sediment impedance and attenuation data to ocean acoustics investigators modeling sound propagation.

APPROACH

The technical approach for the ASIAEX surveys is to collect normal incidence FM reflection data with a towed chirp sonar over the range of 1 to 15 kHz providing images of the top 50 meters of sediments and vertical profiles of acoustic sediment properties for use by ASIAEX scientists modeling acoustic propagation. The multiband chirp technology allows the collection of normal incidence reflection data over a band of 1 to 15 kHz while the towed vehicle emulates a point acoustic source. The point source is emulated using 2 piston sources that operate over different but overlapping frequency bands. Each single piston source has a wide beamwidth (greater than 40 degrees) over its band of operation. Multiple transducers can be driven simultaneously with chirp pulses with different bands to generate the wideband chirp pulse in the water that appears (in the far field) to emanate from a point acoustic

source. Multiple rectangular receiving arrays of various sizes are used to control receiving beamwidth and scattering by spatial filtering. The bandwidth of the sonar provides subsurface imagery with 10 cm vertical resolution. The enhanced bandwidth also improves the accuracy of attenuation and phase measurements needed for impedance inversion and dispersion measurements.

Dr. Schock supervises the research program including graduate and undergraduate students and at sea experiments. Jim Wulf is the lead engineer on the project.

WORK COMPLETED

A chirp sonar survey was conducted in the East China Sea during the period of the 12th through the 23rd of April 2000. A 40 by 100 km area was covered with 11 survey lines.. The water depth varied between 100 and 160 meters. In order to minimize surface and volume scattering noise in the imagery, the sonar vehicle was towed at an altitude ranging between 5 and 20 meters. The chirp sonar transmitted FM pulses over the band of 1 to 15 kHz with pulse length of 10 milliseconds to obtain an average penetration of 60 meters with a vertical resolution of 10 cm. One track line was run once with the sonar towed deep at an altitude of 10 meters and a second time with the sonar towed shallow with a depth of 12 meters. This is done because the sonar system was originally calibrated at a depth of 12 meters. The data sets provide the information needed to corrected the reflection data for changes in the sensitivity of the acoustic arrays due to changes in submergence pressure.

Seven gravity cores were collected along survey lines in the East China Sea. The lengths of the cores were less than 1 meter. The acoustic property data measured from these cores will be used to determine the accuracy of chirp sonar property predictions.

RESULTS

Due to the delay in the instrumentation returning from the East China Sea, there are no results to report from post cruise processing.

IMPACT/APPLICATIONS

Instrumentation and sediment classification procedures have been developed to predict the acoustic and physical properties of the seabed using normal incidence reflection data collected by FM subbottom profilers. This development provides a cost effective method of surveying the top 10 meters of the seabed and obtaining vertical profiles of attenuation, acoustic impedance, volume scattering. From these acoustic property profiles, vertical profiles of physical properties such as bulk density, grain size, and porosity can be estimated. The sonar can also provide calibrated measurements of the seabed reflection coefficient and buried target strengths over the band of 1-45 kHz

TRANSITIONS

The sediment property predictions generated from chirp data will be forwarded to investigators needing seabed acoustic property data for propagation modeling.

RELATED PROJECTS

"Remote Seabed Sediment Classification and Sediment Property Estimation Using High Resolution Refection Profiles," ONR G&G Grant. The techniques developed under this grant are being used to process data for ASIAEX.

PUBLICATIONS

1. " The Development of Chirp Sonar Technology and Its Applications " S. G. Schock and L. R. LeBlanc, AGU Abstract, Dec., 2000. (Submitted)